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File: PR11187 US
"Resilient Supported Reel Spool"

Roller For Winding Up A Material Web

The invention concerns a roller or a reel spool for winding up a material web, especially of paper.

In state-of-the-art spool designs, large roller diameters and bearings, which are positioned at large distances from each other, cause a significant bending of the reel spool core that causes a tendency for the ends to incline. This results in a shifting in the layers of the winding material, which causes shiners to develop. The higher marginal pressure in the paper layers creates a bending stress within the winding material, which in turn leads to shear stress between the paper layers that can cause relative shifting. The bending phenomenon thus constitutes the actual dimensioning criterion for such reel spools, which means that wall thickness and diameter, and consequently weight and cost of such a reel spool are determined by a relatively small marginal area.

The design of a winding tube known from EP-B-0 500 515 includes a double-walled tube construction with two support bearings, which affects the bending line of the outer tube in such a way that the outer tube's edge is kept straight or its inclination is minimized. Likewise, a roller described in DE-B-22 11 892 is designed as a 2-body roller; in which design, the inner body is made up of a solid or massive roller core. Here, a straight external mantle tube surface is achieved by giving a conical shape to the core, onto which the tube is pressed as the load increases. At the edge, the tube may be supported hydraulically or pneumatically.

Another type of elastic roll known from DE-S-23 16 746 for pressure treatment of winding material, envisages a multi-part roller tube / roller core design in which the tube consists of a thermoplastic material. A torsion-resistant but longitudinally movable support of the tube's marginal areas serves to compensate expansion at higher differential temperatures due to different coefficients of thermal expansion. In DE-A-197 29 907, a roller with a 2-body roller core design is described in which the center of the tube is supported by the core, and the wall thickness tapers off toward the edges. The objective here is not to compensate for the global bending of the roller core, but to attain the most constant possible curvature of the roller tube's bending line in order to achieve a spreading effect.

From DE-A-37 03 563, a stretch roller or similar device for paper machine sheets is known featuring a double-walled roller design, in which the center of the fiber-reinforced plastic outer tube is supported by the inner metal tube. Here, too, the objective is to achieve a spreading effect, not compensation for the global bending of the inner tube.

The objective of the present invention is to design an improved roller of the aforementioned type in which the global deflection of the roller body is compensated, at least partially, and the deflection of the roller surface line is reduced accordingly.

This goal is achieved, according to the invention, by a roller for winding up a material web, especially of paper, with a base body and a web-contacting surface, which, in the area of the two roller ends, features a radial flexibility that is higher than in the center of the roller, due to a resilient layer, which is attached to segments of the contacting surface, or due to at least a resilient element, which is attached to the base body, for the purpose of compensating, at least in part, a deflection of the base body that occurs at maximum winding diameter.

Due to this design, deflection of the material of the base body is reduced at least to an extent sufficient to prevent major marginal inclination even at larger winding diameters and wider bearing distances, at the same time avoiding the shifting of layers within the winding material that leads to the development of shiners. The compensation becomes effective in the surface area of the roller base body, attaining, in principle, a Winkler-type bedding. Since the reel spool's dimensions are no longer determined by its vertical deflection or marginal inclination, once the material parameters have been appropriately adjusted, weight is significantly reduced. The lower weight of the reel spool or roller also results in a correspondingly lower load on lifting and transporting devices. The additional cost is minimal. Reel spools already in use can simply be modified appropriately. There is no need to make new ones. Due to the weight reduction, it will not be necessary to adjust the lifting, transporting, and rotating machinery.

The radial thickness of the layer or element, as viewed parallel to the roller axis, may vary. Alternatively or additionally, radial rigidity of the respective layer or elements, as viewed parallel to the roller axis, may also vary.

In certain cases it is advantageous to include - preferably in the central area of the roller - at least one particularly rigid point of support in whose vicinity the radial flexibility of the circumferential surface contacting the web is accordingly lower than in the area of the two ends of the roller.

For a useful and practical implementation, several, particular rigid points of support are envisaged, spaced from each other in an axial direction, and in whose vicinity the radial flexibility of the circumferential surface contacting the web is accordingly lower than in the area of the two ends of the roller.

Preferably, at least one rigid point of support will be, at least partially, formed by the base body itself.

The circumferential surface contacting the web is an appropriate tube enveloping the base body, in particular a resilient tube, in which design the resilient layer, or the resilient element, is positioned radially between the base body and the tube. The preferably resilient tube serves particularly the purpose of equalizing the surface of the roller or reel spool. It may be made, in particular, of metal or it could also be formed by a rubber coating or a similar. This tube would also have to be taken into account when determining the dimensions of the resilient layer or of the resilient elements. Thus, in contrast to known roller types, this is not a supporting tube exposed to a bending load.

In a preferred advantageous embodiment of the roller according to this invention, a resilient layer is attached to the base body, at least in the area of the two ends of the roller, whereby, the layer features a constant radial rigidity over its entire axial length and its general thickness increases toward each end of the roller. In this arrangement, the thickness of the resilient layer may increase toward each of the roller ends, essentially, proportionate to the inclination of the base body occurring at maximum winding diameter. Preferably, the base body tapers off toward each of the roller ends, essentially, in proportion to the increasing thickness of the resilient layer.

In this process, provided there is a compressible layer, a deformed marginal area of smaller diameter develops through surface compression of the resilient layer, resulting in a loosening of the innermost layers in the marginal areas of the roller or reel spool's lower area, which, in turn, facilitates the escape of air. Radial tension, on the other hand, is lost. The goal must be to keep the diameter constant and not just to partially compensate the deflection.

In particular, a rubber-elastic layer may be provisioned to serve as a resilient layer.

The resilient layer may be formed by a particular non-homogenous layer of foamed material and/or honeycomb structure etc.

In a useful and practical embodiment, the resilient, preferably rubber-elastic, layer, which is provisioned at least in the area of the two roller ends, is placed between the base body and the resilient tube, which comprises a rubber coating or the like.

According to another advantageous embodiment of the roller according to the invention, a resilient layer is attached to the base body, at least in the area of the two roller ends, whereby, the resilient layer features a constant thickness over its entire axial length and its radial flexibility generally increases toward each end of the roller.

The resilient layer may, therefore, possess over its axial length, a particularly variable E-modulus. In most cases, however, it should be simpler to provide discrete resilient elements such as discrete spring elements, for example.

Accordingly, another advantageous embodiment of the roller, according to the invention, comprises several resilient elements, serving the purpose of generating the higher flexibility of the web-contacting circumferential surface in the area of the two roller ends as compared with the central area of the roller; the distances between these elements are selected accordingly and/or their flexibility varies accordingly. In this design, the resilient elements may each be, at least partially, embodied as discrete spring elements. Rubber-elastic ring-shaped bodies and/or spring packets extending over the circumference of the base body may, for example, serve as discrete spring elements.

The resilient elements may, at least partially, be pre-stressed.

For the equalization of the web-contacting circumferential surface, again, preferably a resilient tube may be sleeved over.

Since this saves weight, the base body is preferably designed as a hollow body.

According to another advantageous embodiment of the roller, according to the invention, at least two, preferably symmetrical tension anchors are attached in the area of the resilient layer, which is at least partly attached to the base body, and/or at least in the area of the corresponding resilient element that is attached to the base body. The advantage here is that the deflection of the surface line of the roller is further reduced, due to the relations of forces and their distribution. Such tension anchors are well known to experts in the field and are already used in many practical applications.

The tension anchors may be arranged, according to prevailing stress conditions, parallel and/or nearly parallel to the axis of the base body or intersecting diagonally and/or spirally relative to the base body.

Furthermore, the tension anchors are advantageously braced at the roller's front side by means of at least two outer walls, whereby, the tension anchors may be braced diagonally or perpendicularly.

For optimal functionality, the tension anchors are held in their radial position relative to the roller by at least one disc spacer.

The invention is described in more detail below by means of embodiment examples with reference to the drawing. The figures show:

Fig. 1 a schematic, partially sectional representation of a roller for winding a material web with a resilient layer attached to the base body and with a point of support of higher rigidity envisaged in the central area of the roller;

Fig. 2 a schematic, partially sectional representation of another roller embodiment with two separate points of support distanced from each other in an axial direction;

- Fig. 3 a schematic, partially sectional representation of another roller embodiment with several resilient elements distanced from each other in axial direction;
- Fig. 4 a schematic, partially sectional representation of a possible roller base body embodiment whose cross-section reduces toward the ends;
- Fig. 5 a schematic, partially sectional representation of another roller embodiment with zones of varying rigidity;
- Fig. 6 a schematic, partially sectional partial representation of another roller embodiment with a resilient layer whose radial thickness increases toward the roller ends, and which is applied in the roller end area on the base body between it and a rubber coating; and
- Fig. 7 a typical representation of paper pressure over the length of the upper surface line of the roller or reel spool, along the roller, starting from the edge toward the middle of the reel spool, together with a typical representation of the vertical deflection of the reel spool's upper surface line.

Figures 1 to 6 show different embodiments of roller 10 for winding up material web 12, which may particularly be a paper web.

Roller 10 in each case features base body 14, which revolves e.g. on journals 16 protruding into its ends.

By virtue of resilient layer 18 applied at least on sections of base body 14 and/or at least one suitable resilient element 20 arranged on base body 14, envelope 22 contacting the winding material is more radially yielding/ less rigid nearer the two roller ends 24, 24', than in the middle of the roller, in order to at least partially compensate for the deflection of base body 14 when the winding material is thickest.

The radial layer or element thickness and/or radial rigidity of the layer or elements may vary along the length of the roller.

Fig. 1 shows, in schematic, a partial sectional representation of roller 10 with resilient layer 18 applied on base body 14 and a more rigid support point 26 provisioned in the mid-roller area in whose vicinity circumferential surface 22, contacted by the web, is, accordingly, less radially resilient than near the two roller ends 24, 24'.

In this case, a particularly resilient tube 28, surrounding base body 14, constitutes circumferential surface 22, contacted by the web. Tube 28 is supported in the mid-roller area directly by more rigid support point 26. Resilient layer 18 is positioned in the remaining space between tube 28 and base body 14.

As can be seen in Fig. 1, the global deflection of base body 14, at maximal winding material diameter, is at least partially compensated, resulting in an essentially horizontal surface line 30.

Likewise, in the embodiment sample shown in Fig. 2, resilient layer 18 is again designed to be between a particularly resilient tube 30 and base body 14. In this case, two more rigid, particularly completely rigid, support points 26, which are axially distanced from each other, are envisaged. The remaining space between tube 30 and base body 14 is again filled by elastic layer 18 or by elastic elements serving the same purpose. There are at least two preferably symmetrically arranged tension anchors 34 (indicated only symbolically in dashed lines) attached in the area of resilient layer 18, which is applied at least in sections on base body 14. Tension anchors 34 may be attached, dependent on the embodiment and prevailing stress conditions, parallel or nearly parallel to the axis of base body 14, or intersecting diagonally or spirally relative to base body 14. The tension anchors are braced at the front side of roller 10 by means of at least two outer walls 35 (indicated only symbolically in dashed lines), preferably diagonally or in a rectangular manner. In radial direction to roller 10, the tension anchors are held in position by at least one disc spacer 38. If at least two disc spacers are used, these may be arranged to suit different prevailing stress conditions.

Likewise, in the embodiment shown in Fig. 3, base body 14 is again enveloped by a particularly resilient tube 30. In this case, again, a relatively rigid support point 26 is provisioned to be in the mid-roller area. In this case, between the middle roller area and each of the two roller ends, two elastic elements 20 are positioned, axially distanced from each other, between tube 30 and base body 14. These elastic elements 20 may be of rubber, for example, or they may be springs, e.g. steel springs. For example, rubber-elastic ring-shaped bodies or spring packets extending over the circumference of base body 14 or similar may be provisioned. In the vicinity of at least corresponding resilient element 20, positioned on base body 14, at least two preferably symmetrically arranged tension anchors 34 (indicated only symbolically with broken lines) are attached.

Figure 4 shows in schematic, a partial sectional representation of a possible embodiment of roller base body 14 having a cross-section that tapers off toward its ends. Thus, in the mid-roller area, a particular support point 26 may be formed again in whose vicinity the circumferential surface area contacted by the winding material is again less radially resilient or more rigid than near the two roller ends.

On the sections of base body 14, which taper off toward the roller ends, a resilient layer of correspondingly varying radial thickness, for example, or discrete elastic elements of correspondingly varying thickness, for example, may be attached. Even if said layer or elements are of equal rigidity, a higher flexibility or lower rigidity of the surface contacted by the winding material is hereby obtained toward the end of the rollers.

Figure 5 shows, in schematic, a partial sectional representation of another embodiment of roller 10 with sequential zones of different rigidity along the roller, which may be formed by appropriate sections 18' of a resilient layer or by appropriate different resilient elements 20, for example.

In this embodiment, surface 30 contacting the winding material may consist directly of the resilient layer or the elastic elements. No resilient outer tube is therefore provisioned here.

Figure 6 shows, in schematic, a partial sectional representation of another embodiment of roller 10 with resilient layer 18 applied on base body 14 near the roller's ends. In this case, resilient layer 18 is placed near each of the roller's ends between a sector of base body 14 tapering off toward the roller end, and a resilient outer tube 28 formed here by way of example by a rubber coat.

Thus, in this case at least near the two roller ends, resilient layer 18 may be applied on base body 14, which is equally rigid radially all over its axial length and thickens toward the roller ends.

As can be seen in Fig. 6, the radial thickness of resilient layer 18 is greatest near the corresponding roller end.

The roller may be closed off at both of its ends by a lid 32, one of which can be seen in Fig. 6.

In general, base body 14 can be designed as a hollow body. It may be made of steel, for example.

Thus, according to one first variant, a resilient layer of constant rigidity (E-modulus) may be applied all over the length of the surface contacted by the web whose thickness increases from the middle toward the edge proportionally to the global deflection of the base body. In order to obtain a cylindrical outer contour of the load-free roller or reel spool, the marginal area of the base body, which may be a metal tube, for example, may have a conical or parabolic shape.

According to a second variant, a resilient layer of constant thickness all over the length of the surface contacted by the winding material, and having a rigidity that lessens from the roller's center toward the edge proportionally to the global deflection of the reel spool, may be applied, while the base body may be cylindrical.

In principle, a combination of the aforesaid variants is also possible, for example.

Implementation of the first variant is in particular possible through a rubber-elastic layer applied in the marginal zones within a rubber coat. The material properties of this layer are then preferably determined by the requirement of a level surface line, which should be as horizontal as possible.

Implementation of the second variant would require a variable E-modulus over the width of the paper web, if embodied as a material layer. A more easily implemented possibility would, for example, be to use discrete elastic elements or spring elements, which would, for example, provide the necessary variability of bedding rigidity by varying the spaces between these elements and/or by varying the rigidity of the elements. In order to achieve equalization of the roller or reel spool surface, an outer tube may be pulled over the core (wall thickness 5 to 10 millimeters if made e.g. of metal, for example). Such an outer tube would have to be taken into account when calculating the dimensions of the spring elements. It is, however, not to be equated with the deflection-stressed load-bearing tubes of state-of-the-art conventional reel spools. The spring elements can be formed by rubber-elastic ring-shaped bodies, for example, or be implemented as metal spring packets placed around the circumference. Pre-stressing these elements is another possibility.

Especially in connection with the aforementioned first variant of constant rigidity or constant E-modulus (ref. Fig. 6, for example) the material parameters may be determined, or established at least approximately as shown by the following example:

The resilient layer may in particular be modeled as a homogenous layer (marginal thickness 20 mm, for example, thickness near the middle of the reel spool 5 mm, for example, length about 3000 mm, for example) with an E-modulus of about 1 N/mm^2 . This size represents a lower limit of elasticity of polymer materials (E-modulus between 1 and 500 N/mm^2). A rubber coating may serve as a protective layer for the resilient layer.

Calculations indicate that in this case, in spite of a clearly greater overall deflection of the base body, the difference in the excursion of the surface contacted by the winding material (rubber coat) between the margin and mid area has significantly decreased. The greater overall deflection of the base body results, on the one hand, from a reduction in the thickness of the wall of the inner body formed e.g. by a metal tube in the marginal areas (conical shape from e.g. 40 to e.g. 20 mm), and on the other hand, from an equalization of paper pressure at the surface contacted by the winding material (compare Fig. 7). As is evident from Fig. 7, only the sudden end of the resilient layer at this point causes a pressure peak here. An optimization of this transition is to be desired.

For a complete compensation of the base body's global deflection, its contour would have to be parabolic. It can also be seen that the material is a little too rigid at the assumed 1 N/mm and layer densities. This would have to be compensated by further thickening the layer in its marginal areas, or by an even lower E-modulus of the material.

In practice, the following particular requirements would have to be met by the material of the resilient layer:

- it must be highly elastic, even after a 10^8 load changes, for example;

- little fulling/deformation work, even if greatly deformed in each rotation;
- temperature resistance up to the temperature generated by the deformation work;
- inexpensive production and simple application onto the tube.

If the qualities required for functionality cannot be found in one homogenous material, a non-homogenous material, e.g. with ribs and cavities, or a foamed material, would have to be used. The continuation of such an exemplary approach at a solution would lead directly back to the aforementioned second embodiment sample, in which case the variable transversal rigidity could, for example, be realized by means of individual annularly arranged spring elements of variable rigidity.

List Of Designations

10	Roller, reel spool
12	Material web, paper web
14	Base body
16	Journal
18	Resilient layer
18'	Part of resilient layer
20	Resilient element
22	Circumferential surface contacted by the winding material
24	Roller end
24'	Roller end
26	Support point
28	Tube
30	Surface line
32	Lid
34	Tension anchor
36	Outer wall
38	Disc spacers
d	Radial thickness

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Roller For Winding Up A Material Web

Summary

In a roller enveloping a base body for winding up a material web, particularly a paper web, the circumferential surface contacted by the winding material is, due to an appropriate resilient layer applied on at least sections of the base body and/or at least one appropriate resilient element placed on the base body, more radially resilient near the two roller ends than in the mid-roller area, in order to, at least partially, compensate for a deflection of the base body at maximum winding diameter.

(Fig. 1)

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Roller For Winding Up A Material Web

Claims

1. Roller (10) for winding up material web (12), in particular a paper web, with base body (14) and circumferential surface (22) contacting the web, which, due to an appropriate resilient layer (18) applied to at least sections of base body (14) and/or to at least one appropriate resilient element (20) positioned on base body (14), is radially more resilient near the two roller ends (24, 24') than in the mid-roller area, in order to, at least partially, compensate for a deflection of base body (14) at maximum winding diameter.
2. Roller of Claim 1,
wherein
the radial thickness of the layer or element over the length of the roller axis varies.
3. Roller of Claim 1 or 2,
wherein
the radial rigidity of respective layer (18) or elements (20) varies over the length of the roller.
4. Roller of one the preceding Claims,
wherein
at least one particularly rigid support point (26) is provided in the mid-roller area in whose vicinity circumferential surface (22) contacting the material web is, accordingly, radially less resilient than near the two roller ends.
5. Roller of one of the preceding Claims,
wherein
several axially distanced particularly rigid support points (26) are provided in whose vicinity circumferential surface (22) contacting the material web is, accordingly, radially less resilient than near the two roller ends.
6. Rollers of Claim 4 or 5,
wherein

at least one rigid support point (26), at least in part constitutes part of the base body (14) itself.

7. Roller of one of the preceding Claims,
wherein
circumferential surface (22) contacting the material web comprises a particularly resilient tube (28) surrounding base body (14), and resilient layer (18) or resilient element (20) placed radially between base body (14) and tube (28).
8. Roller of Claim 7,
wherein
resilient tube (28) comprises a rubber coating, or similar coating.
9. Roller of one of the preceding Claims,
wherein
a resilient layer (18) of constant radial rigidity over its axial length and generally increasing in thickness (d) toward each of the two roller ends is applied at least near the two roller ends on base body (14).
10. Roller of Claim 9,
wherein
thickness (d) of resilient layer (18) increases toward each of the two roller ends at least approximately in proportion to the deflection of base body (14) at maximal winding thickness.
11. Roller of Claims 9 or 10,
wherein
base body (14) is tapered toward each of the two roller ends at least approximately in proportion to resilient layer's (18) increasing thickness.
12. Roller of one of the preceding Claims,
wherein
resilient layer is formed by rubber-elastic layer (18).
13. Roller of one of the preceding Claims,
wherein
resilient layer (18) is formed by a non-homogenous layer of foamed material and/or honeycomb structure.
14. Roller of one of the preceding Claims,

wherein

a resilient, preferably rubber-elastic layer (18) provided at least near the two roller ends is positioned between base body (14) and resilient tube (28) which, in particular, comprises a rubber coat or similar.

15. Roller of one of the preceding Claims,

wherein

a resilient layer (18) of constant thickness (d) over its axial length and of generally increasing radial resilience toward each of the two roller ends is applied on base body (14), at least near the two roller ends.

16. Roller of one of the preceding Claims,

wherein

several axially distanced resilient elements (20) are provided and their respective spacing is appropriately chosen and/or their respective resilience varies appropriately, in order to render circumferential surface (22) contacting the winding material comparatively more resilient near the roller ends than in the mid-roller area.

17. Roller of one of the preceding Claims,

wherein

resilient elements (20) at least partially comprise one discrete spring element each.

18. Roller of Claim 17,

wherein

resilient elements (20) at least partially comprise one rubber-elastic annular body each.

19. Roller of Claim 17 or 18,

wherein

resilient elements (20), each at least partially comprise a spring packet extending over the base body's (14) circumference.

20. Roller of one of the preceding Claims,

wherein

resilient elements (20) are at least partially pre-stressed.

21. Roller of one of the preceding Claims,

wherein

base body (14) is hollow.

22. Roller of one of the preceding Claims,

wherein

at least two preferably symmetrically arranged tension anchors (34) are positioned on base body (14) in the area of resilient layer (18) applied at least on sections of base body (14) and/or at least on the corresponding resilient elements (20) arranged on base body (14).

23. Roller of Claim 22,

wherein

tension anchors (34) are arranged parallel to the axis and/or approximately parallel to the axis of base body (14).

24. Roller of Claim 22,

wherein

tension anchors (34) are arranged in traverse diagonal manner or spirally relative to base body (14).

25. Roller of one of Claims 22 to 24,

wherein

tension anchors (34) are braced to the front of roller (10) by means of at least two outer walls (36).

26. Roller of Claim 25,

wherein

tension anchors (34) are braced diagonally or in a rectangular manner.

27. Roller of one of Claims 22 to 26,

wherein

tension anchors (34) are held in position in the radial direction of roller (10) by at least one spacer (38).

Fig. 7

Paper pressure (bars)
(upper surface line of reel spool)

Vertical deflection (mm)

(upper surface line of reel spool)

Edge of reel spool

Center of reel spool